

**OBSERVATIONS ON THE NESTING BEHAVIORS OF
TACHYTES PARVUS FOX AND *T. OBDUCTUS* FOX
(HYMENOPTERA: SPHECIDAE)**

FRANK E. KURCZEWSKI AND MARGERY G. SPOFFORD

Department of Environmental and Forest Biology, S.U.N.Y. College of Environmental Science & Forestry, Syracuse, New York 13210.

Abstract.—Various components of the nesting behavior of 11 females of *Tachytes parvus* Fox were studied in upstate New York during July and August 1984. Similar observations on two females of *T. obductus* Fox nesting at the same locality later in the year are included. Particular attention is paid to nest initiation, burrow construction, prey capture and transport, nest entry and exit, cleptoparasitism by miltogrammine flies, wasp countermaneuvers, nest architecture and dimensions, and cell contents, including prey, immature wasps and egg placement. Detailed comparisons are made between the nesting components of the two species based upon this study and review of the literature.

The genus *Tachytes* contains mostly stout-bodied, hairy, beelike wasps distributed throughout the temperate and tropical regions of the world. Bohart and Menke (1976) list 28 nearctic species belonging to several species groups. Members of the *aurulentus* group provision their nests with Tettigoniidae and some of the species have been rather well studied (see Evans and Kurczewski, 1966; Kurczewski and Ginsburg, 1971). Prey records for species belonging to the *pepticus* and *distinctus* groups comprise Acrididae; some of these species have been studied sparingly (see Williams, 1913; Evans and Kurczewski, 1966). Members of the *mergus* group, including *T. mergus* Fox, have a number of unique morphological and behavioral characteristics, which include preying upon Tridactylidae (Krombein and Kurczewski, 1963; Kurczewski, 1966). Behaviorally, the *abdominalis* group contains the most heterogeneous assemblage of species of *Tachytes* in the nearctic region. *T. intermedius* (Viereck) stores Tridactylidae but its behavior differs considerably from that of *T. mergus* (see Kurczewski, 1966; Kurczewski and Kurczewski, 1984). *T. chrysopyga* (Spinola) stores Acrididae, *T. abdominalis* (Say) uses both Acrididae and Tetrigidae, and *T. obductus* Fox preys upon Tetrigidae (Williams, 1913; Kurczewski and Kurczewski, 1971; Kurczewski, 1976).

Tachytes parvus Fox (= *T. pattoni* Banks), another member of the *abdominalis* group, also stores Tetrigidae based upon a single record (Kurczewski and Kurczewski, 1971). Otherwise, nothing is known about the ecology or behavior of this species. It occurs from New Jersey to Florida, westward into Idaho and California (Krombein, 1979).

We found *T. parvus* nesting in a sand-gravel ridge in the town of Sennett, 3.2 km east of Auburn, Cayuga County, NY—400 km outside of its known range—

from 23 July to 8 August 1984. Judging from the contents of nests we excavated the species had been nesting at this site since 18 July. We observed males pursuing females in an attempt to mate with them during 23–28 July, but thereafter no males were seen. We unearthed two females on 28 July from an old (1983?) nest: a general wasp inside of its cocoon; and, another wasp near a broken cocoon beginning to dig its way upward through the soil. This indicates that a portion of the 1984 population had yet to emerge.

We located 11 nests of *T. parvus* between 23 July and 1 August 1984. Nine of the nests were situated in moist, moderately vegetated sand and gravel toward the bottom of the ridge (Fig. 1), and two of the nests were located upslope in almost bare sand. The nest entrances were concealed either at the bases of clumps of grasses, underneath overhanging stems or leaves, between sizeable pebbles, or in a dog footprint (Fig. 2). During provisioning the entrances were left open, but during the construction of a new cell or, sometimes, during the night, the openings were plugged with sand or fine gravel.

Females beginning new nests were observed walking slowly on the sand in a zigzag manner, pausing under leaves, decumbent stems or in depressions, and sampling the sand with the mandibles. Such females also looked into holes, 4–6 mm in diameter, entered partly, then backed out and walked elsewhere. One female searched for a place to dig between 1350 and 1430 h (EDT) on 29 July at a sand surface temperature of 35°C and air (shade) temperature of 29°C. Another female was seen to enter a shallow depression on 23 July and loosen sand with the mandibles. She removed this soil backward with the forelegs and distributed the sand circularly around the rim of the entrance with the hindlegs and abdominal apex, always keeping the midlegs anchored against the sides of the opening. Within 3 min this wasp had disappeared from sight, the only evidence of burrow construction being damp sand pushed periodically into the entrance. After 134 min of (apparent) burrow construction the female appeared in the entrance headfirst, paused, looked around and then made a 4.5 min-long hovering flight (orientation?) above the area of the entrance. During the initial 2 min of the flight, the wasp vigorously wagged her body from side to side while mostly facing the entrance at a height of 20–40 cm. She proceeded to elevate her flight to 1 m or slightly higher during the next 1.5 min, still wagging her body while facing the entrance. She continued to fly higher and further from the entrance during the next min and then disappeared from sight. The flight took place at a sand surface temperature of 52°C and air (shade) temperature of 38°C.

Several females were observed capturing nymphal *Tetrix o. ornata* (Say) (Tetrigidae) on damp sand amidst moderately dense vegetation, often only 1–5 m from their nest entrances. Such wasps searched for prey by flying slowly and sinuously, sometimes hovering, 15–30 cm above the sand. They pounced upon their prey by flying rapidly downward, landed atop the dorsum, bent the abdominal apex underneath the prey's thorax and inserted the sting for a few s. The wasp then remained motionless or cleaned herself for 5–6 s, grasped the prey, usually ventral side upward, by its antennae and body with the mandibles and legs, respectively, and flew rapidly toward the nest. In the vicinity of the nest entrance the provisioning female assumed a slow wagging flight. Smaller, immature prey were difficult to discern beneath the wasps but two larger, adult prey



Figs. 1, 2. 1, Nesting habitat of *Tachytes parvus*, 3.2 km east of Auburn, Cayuga County, New York. Nine nests were located in the moderately vegetated, moist sand and gravel in the foreground. 2, Entrance to nest of *Tachytes parvus*, with marking stake located 2 cm to right. Note sparse vegetation and absence of tumulus.

protruded well beyond the tip of the wasps' abdomens during flight and upon landing.

Provisioning females brought successive prey to their entrances between 1151 and 1659 h at intervals of 1–32 (\bar{x} = 5.5, N = 28) min. There were no significant differences between the mean provisioning rates of five females. A provisioning wasp flew slowly, ca. 30–40 cm above the sand, in an extensive wagging flight, sometimes lasting 30–60 s, then reduced the height of the flight to ca. 20 cm prior to entering the open nest. Some wasps landed up to 60–70 cm from their entrances and paused on the sand for 30–60 s prior to entry, whereas females pursued by cleptoparasitic Miltogramminae (Diptera: Sarcophagidae) did not enter but turned abruptly and flew away only to return s or min later. After entering with prey the females spent from 0.3 to 2.0 (\bar{x} = 1.1, N = 22) min inside the nest before exiting headfirst. Most wasps exited rapidly in flight but a few spent 5–50 s in a low, wagging flight (reorientation?) above the area of the entrance prior to flying away. Entry flights of non-provisioning females were straight and faster than those of provisioning wasps.

When attempting to elude species of Miltogramminae, the wasps exhibited atypical flight patterns and spent several min per provisioning trip. Sometimes the wagging flight of the provisioning female sufficed as a distractor, but four times a female of *Phrosinella aurifacies* Downes and three times one of *Senotainia trilineata* (Wulp) entered an entrance shortly after the provisioning wasp had gone inside. The flies exited 5–8 s later. Twice, females with prey were seen to convert their wagging provisioning flight into a rapid straight flight several meters in length in an attempt to elude a trailing *S. trilineata*. Both times the provisioning wasp's quick flight was successful and she returned and entered the nest minus the fly. But one wasp with an adult prey returned and landed with an *S. vigilans* Allen female riding on the prey's protruding abdominal sternites. The *S. vigilans* had been seen earlier lurking on upright vegetation near the wasp's entrance.

Provisioning wasps pursued by miltogrammine flies also landed 30–90 cm from the entrance, often in the shade beneath vegetation, and remained still, interspersed with wagging flights and rapid "escape" flights. One such female spent 8 min attempting unsuccessfully to evade two trailing *S. trilineata* females. If unsuccessful in eluding an *S. trilineata* in the vicinity of their nest, some provisioning wasps flew at, "buted" (see Lin, 1963) and knocked the fly to the ground. Another *S. trilineata*, which had sat on an overhanging stem near a wasp's entrance, was actually attacked by the provisioning wasp in midair, knocked to the ground and stung, after the female had released her prey. The fly lay immobile for 1.5 min after which it was placed in a vial and began to recover from the effects of the sting. The wasp flew away, abandoning its prey on the sand. Prior to this attack the provisioning wasp and fly had "faced-off" (see Spofford et al., 1986) on the sand for 8 s. The same wasp, upon returning with an additional prey, was pursued in flight by another *S. trilineata*, which then attached itself by clinging to the pair and attempted to larviposit on the prey. The wasp landed, cleaned herself, groomed the prey for 8 s, restung it and flew into the entrance. The female met the same fate on her next provisioning flight and she reacted in the same manner, only this time she turned, after exiting, and reentered her nest instead of flying away rapidly. Whether or not reentry was related to the attempted larviposition by the fly is unknown. Despite all of the various behavioral mech-

anisms exhibited by this species of wasp in an attempt to deter cleptoparasitic flies of the tribe Miltogrammini from larvipositing on the prey, 2 of 19 (10.5%) of the cells when examined contained maggots rather than wasp eggs or larvae. Both maggots formed puparia from which male *S. trilineata* and *P. aurifacies* emerged on 13 August 1984 and 24 April 1985, respectively.

Four females of *T. parvus* spent 50, 53, 75 and 80 min constructing an additional cell inside the nest beginning at 1411, 1537, 1338, and 1132 h, respectively. During this addition the wasp must have removed sand from the new excavation to an old (side) burrow because she did not bring sand out of the entrance onto the surface. The tumulus thus becomes nonexistent after the construction of the main burrow and first cell.

We excavated five unfinished nests of this species, the largest one containing eight fully-provisioned cells. Four of the five nests were contained within an area with a radius of 1.2 m. Entrances to newly constructed nests ($N = 4$) were 4–5 mm in diam and were surrounded by circular tumuli, ca. 2.5 cm in diam, or fronted by fan-shaped tumuli measuring ca. $3.5\text{--}4.0 \times 4.0\text{--}4.5$ cm. In a day or so these tumuli become sun-dried and windblown and are virtually indistinguishable from the surrounding sand. Older nests actually have 5–10-mm-long, fan-shaped “runways” leading into their entrances. The burrows entered the sand at $25^\circ\text{--}45^\circ$ angles to the surface for 3–6 cm, then either looped backwards or went almost vertically; some even turned or looped a second time (Fig. 3). One such burrow, 22.7 cm long, was traced to its blind ending at a depth of 8.8 cm beneath the surface, and another, 15.5 cm long, to a cell. Four of the five nests had blind chambers (spurs), 1.5–2.1 cm long; three were just beneath the entrance and one, at a depth of 3.8 cm. Cells containing prey and wasps in various stages of development were unearthed either below the entrance amidst a myriad of small pebbles and rootlets or, more usually, spaced widely in various directions in bare sand, 9–59 cm from the entrance (Fig. 3). In four of the five nests the cells were unearthed uphill of the entrance, the exception being a nest on top of the ridge in bare, dry, loose sand. Adjacent cells in one nest were uncovered 1–14 ($\bar{x} = 5.4$; $N = 7$) cm apart.

The cells were found at various depths, depending upon the type of soil, amounts of moisture and vegetation (rootlets), and slope of sand surface. For example, one cell in highly vegetated, moist, gravelly soil was only 7.7 cm deep, including cell height; six cells in moderately vegetated, moist, gravelly-sand, 8.0–10.5 cm deep; nine cells in sparsely vegetated, moderately moist, coarse sand, 11.0–12.0 cm deep; eight cells in almost bare, drier sand, 12.5–15.0 cm deep; and, four cells in bare, dry, loose sand, 15.5–16.0 cm deep. In one nest the oldest cells, as based upon their contents, were located furthest from the entrance at increasingly greater depths. Another nest had all but two of eight cells at about the same depth, but again the cells furthest from the entrance were invariably the oldest.

The cells were either perfectly ovoidal or slightly narrower at their distal ends. They ranged in size from 5×10 to 7×14 ($\bar{x} = 6.0 \times 12.3$; $N = 11$) mm in height and length, respectively. Although eight smaller cells ($5\text{--}6 \times 10\text{--}12$ mm) each contained only 4, 5 or 6 prey and eight larger ones ($6\text{--}7 \times 13\text{--}14$ mm) each held 7, 8 or 9 prey, suggesting a correlation between cell size and number of prey per cell, the smaller cells were unearthed in moderately vegetated, moist, gravelly-sand and the larger cells in almost bare, drier sand.

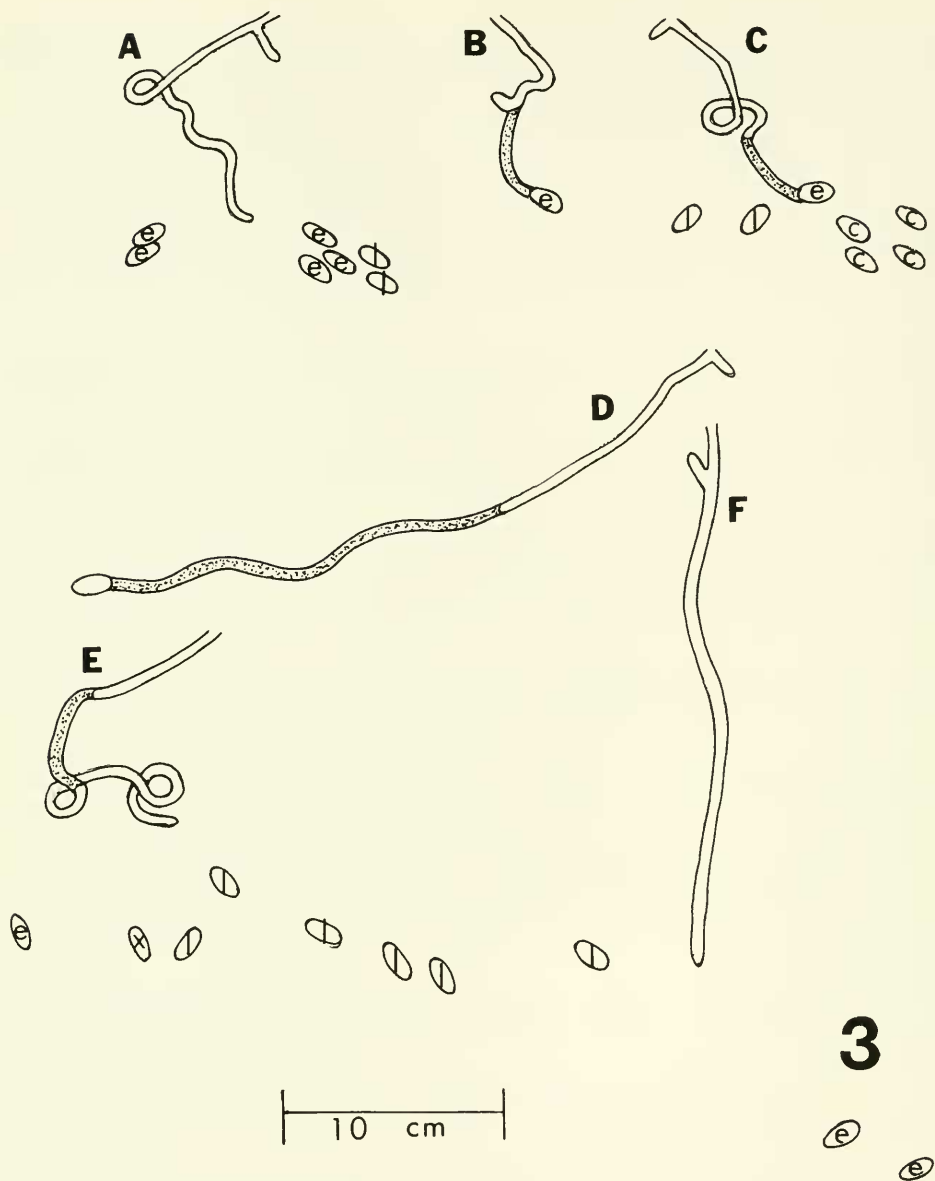


Fig. 3. Nests of *Tachytes parvus* (A-E) and *T. obductus* (F), as viewed from the side, showing burrows and cells. Nest E is 8-celled and nest F, 2-celled. Cell contents are as follows: e, egg; l, larva; c, cocoon; x, maggots. Stippling indicates burrow is filled with sand. The scale refers to all nests except nest E in which the cell distances have been compacted horizontally.

A total of 99 nymphal and 3 adult prey were recovered from the cells and 24 of these were identified as *Tetrix o. ornata*. The number of prey stored in a cell varied from 4 to 9 ($\bar{x} = 6.0$; $N = 17$), although, as indicated, cells within a nest tended to contain similar numbers of prey per cell. Individual prey weighed (wet) from 3.0 to 29.3 ($\bar{x} = 13.8$; $N = 89$) mg, whereas the total weight of all prey in a

cell ranged from 46 to 141 ($\bar{x} = 88.4$; $N = 14$) mg. Cells with more prey almost invariably contained more biomass than cells with fewer prey. Three female wasps weighed (wet) 27, 39, and 39 mg.

The prey were positioned in the cells variously: 48, head inward and ventral side upward; 6, head outward and ventral side upward; 10, head inward and dorsal side upward; 6, head inward and on the side; and, 1, head outward and on the side. Eggs (8) or small larvae (3) were attached to prey that were positioned head inward and ventral side upward, usually near the top of the cell atop other prey.

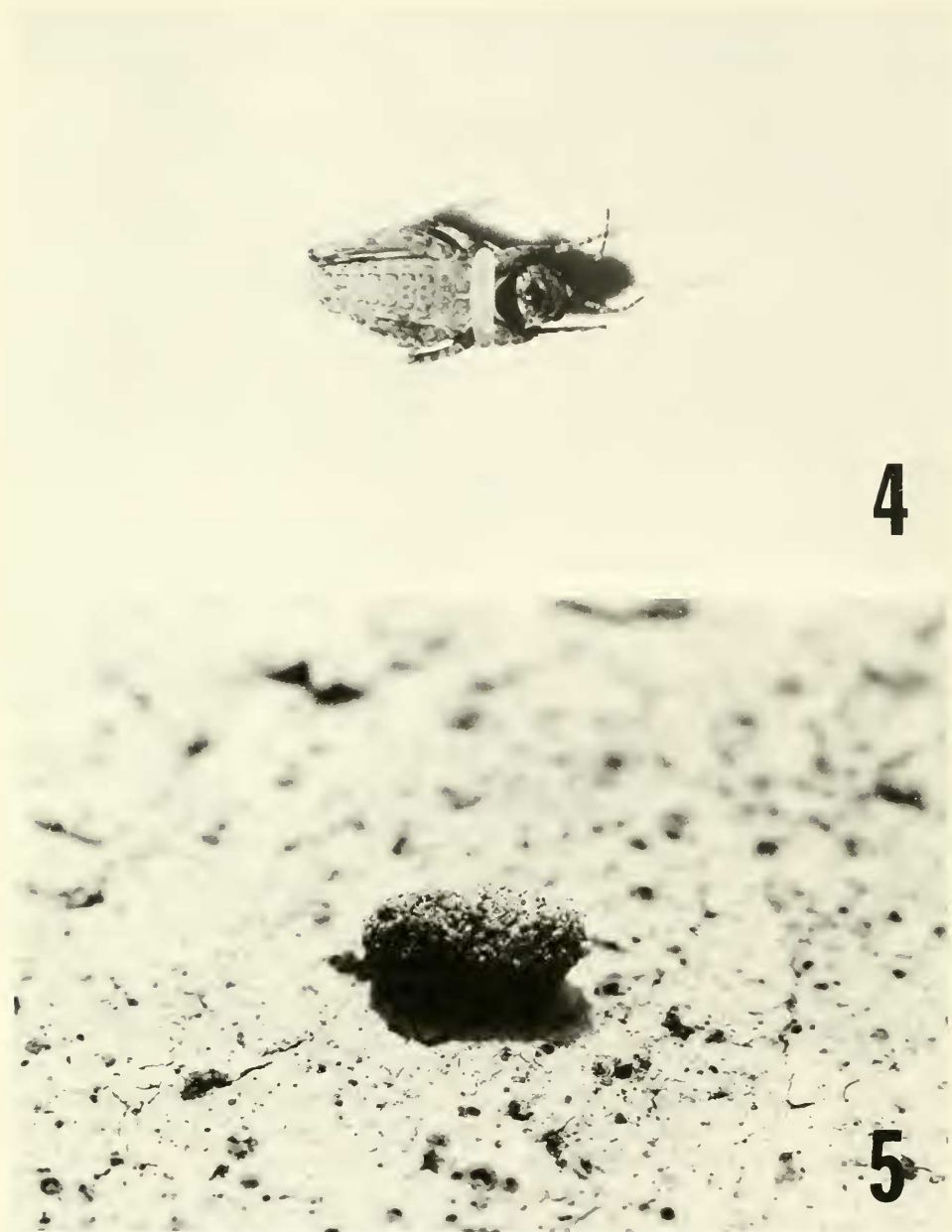
The egg of *T. parvus* is white and sausage-shaped and is affixed by its cephalic end to a forecoxal corium of the prey, extending transversely between the first two pairs of legs (Fig. 4). Of eight eggs attached to prey, five were affixed to the right forecoxal corium and three to the left. Two eggs were placed on the third largest prey in the cell and one on the second largest. Larvae hatched in ca. 48 h. Mature larvae began spinning cocoons ca. 5 d later. The cocoon is ovoidal and consists of silk, saliva and sand grains (Fig. 5). Four cocoons ranged in size from 3.0×7.0 to 3.5×8.0 ($\bar{x} = 3.3 \times 7.6$) mm.

At the same site later in the year (26–31 Aug 1984) we located two females of *T. obductus* nesting in the top and in the upper slope of the sand-gravel ridge in which *T. parvus* had nested. The first female had a nest in bare sand topped with a gravelly crust. Her burrow, 7 mm in diameter, with a small side chamber (spur), 2 cm down, went almost vertically downward for 24 cm. There was no tumulus on the sand surface. Two cells were located at depths of 33 and 34 cm, including cell height, 10 and 15 cm southwest of the burrow terminus. Cell *A* was 6×14 mm in height and length, respectively, and contained four immature *Tetrix o. ornata*. Three of the tetrigids were positioned head inward and ventral side upward, including the egg-bearer, and one, head inward and dorsal side upward. The egg was attached to the right forecoxal corium of a medium-sized prey (wet wt., 22 mg), and it extended transversely between the fore- and midcoxae. The total weight (wet) of all prey in the cell was 96 mg, with individual prey weights ranging from 11.5 to 31.0 mg.

Cell *B* contained five *T. o. ornata*, including four immatures and one adult male. Two of these prey, including the egg-bearer at the top of the cell, were positioned head inward and ventral side upward and one, head inward and dorsal side upward. The cell measured 7×13 mm in height and length, respectively. The egg was attached to the right forecoxal corium of an immature tetrigid, as described above. The egg-bearing prey weighed (wet) 21 mg, and the adult male, 27 mg. The total weight of all prey in the cell was 106 mg.

The burrow of the second female, 6 mm in diameter, entered the sandy cliff perpendicularly, and then turned and proceeded almost straight downward. The tumulus, 8.5×14.5 cm, consisting of freshly removed, agglutinated pellets of damp sand, laid below the entrance. We spent parts of three days in excavating this nest but were unsuccessful in finding any of the cells. Based upon the sequence of provisioning, including the intermittent lengthy pauses, we believe there were two cells each containing four prey. We observed this female, one day before she began provisioning, entering open holes in the cliff face, presumably searching for a place to begin digging.

Females of *T. obductus* were observed hunting for prey in low quick flights, interspersed with searching under *Equisetum* and other low plants within 1.1–



Figs. 4, 5. 4, Egg of *Tachytes parvus* affixed transversely to immature *Tetrix o. ornata* between first two pairs of legs. 5, Cocoon of *Tachytes parvus* consisting of sand grains, silk and saliva.

4.0 m of their nest entrances. The provisioning wasps were observed arriving from distances of 50–70 cm in rapid, sinuous flights, 10 cm or less above the sand surface, and quickly plunging into their open entrances, holding the prey underneath. One provisioning wasp landed 30 cm from her entrance, rested atop her prey, and then flew into the entrance. Twice, female *A* was pursued into her entrance by a female of *Senotainia vigilans*, but neither cell was found to be

cleptoparasitized when this nest was excavated. After placing prey in their nests the wasps exited in rapid flights, less than 50 cm above the sand surface, except for one female which turned and hovered, facing the entrance, for 20 s before flying away. Once, female *B* appeared headfirst in her entrance, after taking in prey, came out five times to obtain sand, each time backing in with a load, then turned around and plugged the opening with sand. The two wasps spent 47 and 54 min, respectively, apparently to construct an additional cell. They utilized from 2 to 23 (\bar{x} = 9.4; N = 12) min between successive provisioning trips between 1335 to 1458 h (EDT). The wasps stayed inside from 0.8 to 2.5 (\bar{x} = 1.6; N = 12) min between entering with prey and exiting from the entrance.

DISCUSSION

Tachytes obductus and *T. parvus*, both members of the *abdominalis* group, are rather similar in size, adult external morphology, geographical distribution, habitat, nesting behavior and prey preference. Both are "small" species of *Tachytes*, the females averaging ca. 10 mm in body length. *T. obductus* averages slightly larger than *T. parvus*, but there is size overlap. As members of the *abdominalis* group, *T. obductus* and *T. parvus* share a number of external adult morphological characteristics (Banks, 1942). However, in the field, the two species are recognized easily because *T. obductus* is all-black while in *T. parvus* the first two or three abdominal segments are rufous. The species' ranges are sympatric throughout much of the eastern United States east of the 100th meridian, with *T. parvus* extending westward into Idaho and California (Krombein, 1979). We have found both *T. obductus* and *T. parvus* nesting in the same area of sand-gravel, constructing nests of similar architecture and dimensions, and preying upon the same species of Tetrigidae.

Although the two species may occupy the same area of friable soil *T. obductus* prefers bare, dry slopes and hills of sand-gravel, whereas *T. parvus* prefers moderately vegetated, rather flat, moist sand-gravel. Kurczewski and Kurczewski (1971) also noted *T. obductus* nesting in the slope and on the flats of a sand-gravel "bank." The area where F. E. Kurczewski (1976) observed this species nesting near Sennett, New York is a mixed, coarse sand and fine gravel slope. Kurczewski and Kurczewski (1971) reported *T. parvus* (= *T. pattoni*) flying with prey at Kill Devil Hills, North Carolina. This area comprised moderately vegetated, moist sand flats behind the beach. In central New York where the present studies were made, *T. parvus* nested earlier (18 July–8 August) than *T. obductus* (14 August–1 September). Kurczewski and Kurczewski (1971) reported the latter species nesting from 29 July to 10 August in Albany County, New York. One female of *T. parvus* in the CESF Insect Museum was collected on 10 June 1983 (Albany Co., New York; J. C. Allen), further indicating that this species may nest earlier than *T. obductus*.

In searching for a place to nest the two species exhibit similar behavior. They fly slowly, periodically land and examine, and, sometimes enter, open holes and depressions, and, occasionally, dig with the mandibles. Although initial burrow construction was observed only for *T. parvus*, the components exhibited while building additional cells are similar for the two species, both taking approximately one hour to add a cell to a nest, usually during early-mid afternoon. Tumuli of *T. obductus* nests in slopes are distinctly ovoidal, whereas those of *T. parvus* nests in flat sand are slightly ovoidal or circular. In both species the tumulus becomes

obsolete due to the action of the sun and wind. In both *T. obductus* and *T. parvus* the entrance remains open during provisioning, but may be plugged during the addition of a new cell or during the night (*T. parvus*). Both *T. obductus* and *T. parvus* hunt for prey in late morning and throughout much of the afternoon, pausing only to feed and construct additional cells. *T. obductus* searches for prey 1–4 m from its nest in low, rapid flights, whereas *T. parvus* hunts 1–5 m from the entrance in slow, sinuous, sometimes hovering, flights. Williams (1913) noted *T. abdominalis* (Say), a species similar to *T. parvus*, hunting “rather slowly,” but he reported *T. obductus* running on the ground, while hunting, “at a moderate speed . . .” Components of prey capture appear to be essentially identical in *T. obductus* and *T. parvus*. Prey transport in the two species differs strikingly, however, and may be correlated with the prey searching flights. Provisioning females of *T. obductus* return to the nest in rapid, sinuous flights, 10 cm or less above the ground, and plunge quickly into their entrances, whereas females of *T. parvus* with prey exhibit a slow, wagging flight, 20–40 cm above the entrance, prior to entry. In the present study females of *T. obductus* spent about twice as much time in obtaining prey as did females of *T. parvus*, and about 1.5 times as long between entering with prey and exiting. These durations may reflect the abundance of prey at different times of the season and the differential depths of the cells, respectively. Both species exit in a rather straight, rapid flight.

We found no evidence of cleptoparasitism by miltogrammine flies (Sarcophagidae) in our examination of the cells of *T. obductus*, nor has any such cleptoparasitism been reported for this species. Our study of the nests of *T. parvus* reveals a relatively small amount of cleptoparasitism by the miltogrammine fly, *Senotainia trilineata*. Perhaps the low, rapid provisioning flight and the rather deep nest of *T. obductus* serve as deterrents to fly cleptoparasitism. The “wagging” provisioning flight, rapid “escape” flight, “freeze-stop” (Alcock, 1975), “butt” (Lin, 1963), “knock-down” and sting, coupled with the relatively deep, tortuous nest of *T. parvus* undoubtedly serve to reduce the amount of cleptoparasitism by miltogrammine flies on this species.

The nests of both species of *Tachytes* are somewhat variable in configuration and size. Unfinished nests of *T. obductus* may contain up to six cells (Kurczewski and Kurczewski, 1971), whereas those of *T. parvus* may be 8-celled. Multicellular nests are the rule in species of *Tachytes* (Evans and Kurczewski, 1966). Nests of members of the *abdominalis* group tend to be more lateral and less vertical in composition than those of species belonging to the *aurulentus* group (Evans and Kurczewski, 1966; Kurczewski and Ginsburg, 1971). The main burrows of *T. obductus* and *T. parvus* may be as long as 47 and 59 cm, respectively. Cell depth in both species varies, seemingly with soil type (friability) and amounts of moisture and vegetation. For example, in *T. parvus* the shallowest nests (cells) were constructed in moderately to highly vegetated, moist, gravelly soil while the deepest nests (cells) were situated in bare, dry, loose sand. In *T. parvus* the cells furthest from the entrance in a nest are provisioned first and those nearest the entrance, last. In nests of both *T. obductus* and *T. parvus* a short spur often bifurcates from just below the entrance. Whether or not this space serves as a sleeping “chamber” for the wasp, a distractor for cleptoparasites, such as *Phrosinella aurifacies*, or simply represents a portion of the preexisting depression from which the nest is begun is unknown.

The cells in the nests of both species are similar in shape and size, with those of *T. obductus* being slightly larger. In the present study females of *T. obductus* were slightly larger and heavier (\bar{x} = 45 mg) than those of *T. parvus* (\bar{x} = 35 mg) and this size differential may account for differences in the provisions of the cells. Thus *T. obductus* selects a mix of adult and nymphal tetrigids (*Tetrix ornata*, *Paratettix cucullatus*) (Kurczewski and Kurczewski, 1971; Kurczewski, 1976), whereas *T. parvus* stores almost 100% nymphal *Tetrix ornata*. Kurczewski and Kurczewski (1971) reported nymphal *Neotettix femoratus* (Scudder) as prey of *T. parvus* (= *T. pattoni*) in coastal North Carolina. Reflecting this differential use of adults/nymphs, *T. obductus* stored 3–7 (\bar{x} = 4.3) prey per cell, averaging 26.2 mg each (includes prey transport specimens and incompletely and fully-provisioned cells from this study and that of Kurczewski, 1976), for a total prey weight per cell of 104.8 mg (includes fully-provisioned cells from this study and that of Kurczewski, 1976), whereas *T. parvus* provisioned with 4–9 (\bar{x} = 6.0) prey per cell, averaging 13.8 mg each (includes prey transport specimens and fully-provisioned cells from this study), for a total prey weight per cell of 88.4 mg (includes only fully-provisioned cells from this study).

The placement of prey in the cells of both species is identical, i.e. mostly head inward and ventral side upward but also in various other positions. In both species the egg is laid on a "medium-sized" grouse-locust in the cell. The egg-bearing tetrigid is often positioned atop other prey near the top of the cell. The shape, size and placement of the egg is essentially identical in the two species and the placement seems to be consistent with that of other species of *Tachytes* that have been studied (Krombein and Kurczewski, 1963; Evans and Kurczewski, 1966; Kurczewski and Ginsburg, 1971; Kurczewski and Kurczewski, 1984).

ACKNOWLEDGMENTS

We thank K. V. Krombein, Smithsonian Institution, and W. J. Pulawski, California Academy of Sciences, for confirming the identity of *Tachytes parvus*, W. L. Downes, Jr., Michigan State University, for confirming the *Phrosinella aurifacies*, *Senotainia trilineata* and *S. vigilans* identifications, and I. J. Cantrall and T. Cohn, Museum of Zoology, The University of Michigan, for naming *Tetrix o. ornata*.

LITERATURE CITED

- Alcock, J. 1975. The nesting behavior of *Philanthus multimaculatus* Cameron (Hymenoptera, Sphecidae). *Am. Midl. Nat.* 93: 222–226.
- Banks, N. 1942. Notes on the United States species of *Tachytes* (Hymenoptera: Larridae). *Bull. Mus. Comp. Zool.* 89: 395–436.
- Bohart, R. M. and A. S. Menke. 1976. Sphecids wasps of the world. A generic revision. Univ. Calif. Press, Berkeley. ix + 695 pp.
- Evans, H. E. and F. E. Kurczewski. 1966. Observations on the nesting behavior of some species of *Tachytes* (Hymenoptera: Sphecidae, Larrinae). *J. Kans. Entomol. Soc.* 39:323–332.
- Krombein, K. V. 1979. Family Larridae, pp. 1617–1650. *In* Krombein, K. V., et al., eds. *Catalog of Hymenoptera in America north of Mexico*. Vol. 2. Smithsonian Inst. Press, Washington, D.C.
- Krombein, K. V. and F. E. Kurczewski. 1963. Biological notes on three Floridian wasps (Hymenoptera, Sphecidae). *Proc. Biol. Soc. Wash.* 76: 139–152.
- Kurczewski, F. E. 1966. Behavioral notes on two species of *Tachytes* that hunt pygmy mole-crickets (Hymenoptera: Sphecidae, Larrinae). *J. Kans. Entomol. Soc.* 39: 147–155.

- . 1976. Behavioral observations on some Tachytini and Larrini (Hymenoptera: Sphecidae). *Ibid.* 49: 327–332.
- Kurczewski, F. E. and S. E. Ginsburg. 1971. Nesting behavior of *Tachytes (Tachyplena) validus*. *Ibid.* 44: 113–131.
- Kurczewski, F. E. and E. J. Kurczewski. 1971. Host records for some species of *Tachytes* and other Larrinae. *Ibid.* 44: 131–136.
- . 1984. Mating and nesting behavior of *Tachytes intermedius* (Viereck) (Hymenoptera: Sphecidae). *Proc. Entomol. Soc. Wash.* 86: 176–184.
- Lin, N. 1963. Territorial behaviour in the cicada killer wasp, *Sphecius speciosus* (Drury). I. *Behaviour* 20: 115–133.
- Spofford, M. G., F. E. Kurczewski, and D. J. Peckham. 1986. Cleptoparasitism of *Tachysphex terminatus* (Hymenoptera: Sphecidae) by three species of Miltogrammini (Diptera: Sarcophagidae). *Ann. Entomol. Soc. Am.* (In press.)
- Williams, F. X. 1913. Monograph of the Larridae of Kansas. *Univ. Kans. Sci. Bull.* 8: 117–213.